

WHAT IS CLAIMED IS:

1. An image forming method, comprising:

a charging step of charging an image-bearing member by charging means comprising a charging member  
5 supplied with a voltage and abutted against the image-bearing member at a contact position;

a latent-image forming step of forming an electrostatic latent image on the charged image-bearing member,

10 a developing step of transferring a magnetic toner carried on a toner-carrying member onto the electrostatic latent image to develop the latent image, thereby forming a magnetic toner image on the image-bearing member, and

15 a transfer step of electrostatically transferring the magnetic toner image on the image-bearing member onto a transfer material via or without via an intermediate transfer member,

wherein the image-bearing member comprises an  
20 electroconductive support and a photoconductor layer comprising a silicon-based non-single crystal material and disposed on the electroconductive support, and is charged to a potential of 250 to 600 volts in terms of an absolute value via the charging member abutted  
25 against it,

the magnetic toner includes magnetic toner particles comprising at least a binder resin and a

magnetic iron oxide, and inorganic fine powder and electroconductive fine powder present at the surface of the magnetic toner particles,

the magnetic toner has a weight-average  
5 particle size of 3 - 10  $\mu\text{m}$ ,  
the magnetic toner has an average circularity  
of 0.950 to 0.995, and  
the magnetic toner contains 0.05 to 3.00 % of  
isolated iron-containing particles.

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2. The method according to Claim 1, wherein in the charging step, electroconductive fine powder is present between the charging means and the image-bearing member.

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3. The method according to Claim 1, wherein in the charging step, the image-bearing member is charged to a potential of 250 to 550 volts in terms of an absolute value.

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4. The method according to Claim 1, wherein in the charging step, the image-bearing member is charged to a potential of 250 to 500 volts in terms of an absolute value.

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5. The method according to Claim 1, wherein the magnetic toner has a magnetization of 10 - 50  $\text{Am}^2/\text{kg}$

at a magnetic field of 79.6 kA/m.

6. The method according to Claim 1, wherein the magnetic toner contains 0.05 - 2.00 % of isolated  
5 iron-containing particles.

7. The method according to Claim 1, wherein the magnetic toner contains 0.05 - 1.50 % of isolated  
10 iron-containing particles.

8. The method according to Claim 1, wherein the magnetic toner contains 0.05 - 0.80 % of isolated  
iron-containing particles.

9. The method according to Claim 1, wherein the magnetic toner has an average circularity of 0.970 to  
15 0.995.

10. The method according to Claim 1, wherein the magnetic toner has a mode circularity of at least  
20 0.990.

11. The method according to Claim 1, wherein the magnetic iron oxide in the magnetic toner has been  
25 surface-treated in an aqueous medium with a coupling agent hydrolyzed in the medium.

12. The method according to Claim 1, wherein the inorganic fine powder blended with the magnetic toner particles in the magnetic toner has an average primary particle size of 4 - 80 nm.

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13. The method according to Claim 12, wherein the inorganic fine powder comprises at least one member selected from the group consisting of silica, titanium oxide alumina and double oxides of these.

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14. The method according to Claim 1, wherein the inorganic fine powder has been hydrophobized.

15. The method according to Claim 14, wherein the inorganic fine powder has been treated with at least silicone oil.

16. The method according to Claim 14, wherein the inorganic fine powder has been treated with at least a silane compound and silicone oil.

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17. The method according to Claim 1, wherein the electroconductive fine powder is non-magnetic.

18. The method according to Claim 17, wherein the magnetic toner has a resistivity of at most  $10^9$  ohm.cm, and the electroconductive fine powder has a

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volume-average particle size smaller than that of the magnetic toner and is contained in a proportion of 0.2 - 10 wt. % of the magnetic toner.

5        19. The method according to Claim 17, wherein the non-magnetic electroconductive fine powder has a resistivity of at most  $10^6$  ohm.cm.

10        20. The method according to Claim 17, wherein at least a surface portion of the non-magnetic electroconductive fine powder comprises a metal oxide which contains a principal metal element and also an element different from the principal metal element in a proportion of 0.1 - 5 atom. % of the principal metal  
15        element, or a metal oxide in an oxygen-deficient state.

20        21. The method according to Claim 1, wherein the magnetic toner contains a wax in a proportion of 0.1 - 20 wt. % of the magnetic toner.

25        22. The method according to Claim 1, wherein the wax has a maximum heat-absorption peak temperature of 40 - 110 °C as measured by differential scanning calorimetry.

23. The method according to Claim 1, wherein the

wax has a maximum heat-absorption peak temperature of 45 - 90 °C as measured by differential scanning calorimetry.

5        24. The method according to Claim 1, wherein the electroconductive support of the image-bearing member has a cylindrical shape, and the image-bearing member is free from a heater therefor inside the cylindrical support.

10        25. The method according to Claim 1, wherein the image-bearing member has a laminate structure including an electroconductive support, a photoconductor layer comprising a silicon-based non-  
15        single crystal material and a surfacemost layer comprising a non-single crystal material different from that of the photoconductor layer.

20        26. The method according to Claim 25, wherein the surfacemost layer comprises a non-single crystal carbon hydride film.

25        27. The method according to Claim 1, wherein the developing step is operated to also function as a step of recovering a portion of the magnetic toner remaining on the image-bearing member after the transfer step of transferring the toner image onto the

transfer material.

28. The method according to Claim 1, wherein in  
the charging step, the image-baring member is charged  
5 by the charging member in the presence of  
electroconductive fine powder present in a density of  
at most  $10^3$  particles/mm<sup>2</sup> at the contact position.

29. The method according to Claim 1, wherein in  
10 the charging step, the image-bearing member is charged  
while moving the image-baring member and the charging  
member so as to provide a relative speed difference  
between surface moving speeds of these members at the  
contact position.

15 30. The method according to Claim 29, wherein in  
the charging step, the image-bearing member and the  
charging member are moved in mutually opposite surface  
moving directions at the contact position.

20 31. The method according to Claim 1, wherein in  
the charging step, the charging member is a roller  
member having an Asker C hardness of at most 50 deg.

25 32. The method according to Claim 1, wherein in  
the charging step, the charging member is a roller  
member having a volume-resistivity of  $10^3 - 10^8$

ohm.cm.

33. The method according to Claim 1, wherein in the charging step, the charging member is a roller member having a surface provided with minute cells providing an average spherical cell diameter of 5 - 300  $\mu\text{m}$  and a void areal percentage at the surface of 15 - 90 %.

34. The method according to Claim 1, wherein in the charging step, the charging member is an electroconductive brush member.

35. The method according to Claim 1, wherein in the charging step, the charging member is supplied with a DC voltage alone or in superposition with an AC voltage having a peak-to-peak voltage of below  $2 \times V_{th}$  relative to a discharge initiation voltage  $V_{th}$  in DC voltage application.

36. The method according to Claim 1, wherein in the charging step, the charging member is supplied with a DC voltage alone or in superposition with an AC voltage having a peak-to-peak voltage of below  $V_{th}$  relative to a discharge initiation voltage  $V_{th}$  in DC voltage application.



37. The method according to Claim 1, wherein the charging member comprises magnetic particles.

38. The method according to Claim 1, wherein in the charging step, the charging member comprises a magnetic brush formed of magnetically constrained magnetic particles and is supplied with a voltage while contacting the image-bearing member to charge the image-bearing member.

39. The method according to Claim 38, wherein the magnetic particles have a volume-basis median diameter of 10 - 50  $\mu\text{m}$ .

40. The method according to Claim 38, wherein the magnetic particles have a volume resistivity of  $1 \times 10^4$  -  $1 \times 10^9$  ohm.cm.

41. The method according to Claim 1, wherein the electrostatic latent image is a digital latent image.

42. The method according to Claim 1, wherein in the developing step, the magnetic toner is carried in a layer at a density of 5 - 50  $\text{g/m}^2$  on the toner-carrying member to develop the electrostatic latent image on the image-bearing member.

43. The method according to Claim 1, wherein in the developing step, the magnetic toner is carried on the toner-carrying member in an amount regulated by a ferromagnetic metal blade disposed opposite to and  
5 with a small gap from the toner-carrying member.

44. The method according to Claim 1, wherein in the developing step, the toner-carrying member is disposed opposite to and with a gap of 100 - 1000  $\mu\text{m}$   
10 from the image-bearing member.

45. The method according to Claim 1, wherein in the developing step, the magnetic toner is disposed on the toner-carrying member in a layer thickness smaller  
15 than a gap between the toner-carrying member and the image-bearing member, and is transferred onto the image-bearing member to develop the electrostatic latent image thereon.

46. The method according to Claim 1, wherein in the developing step, a developing bias voltage comprising at least an AC voltage is applied so as to form an alternating electric field between the toner-carrying member and the image-bearing member, wherein  
25 the alternating electric field has a peak-to-peak intensity of  $3 \times 10^6 - 1 \times 10^7$  V/m and a frequency of 100 - 5000 Hz.

47. The method according to Claim 1, wherein in the transfer step, a transfer member is abutted against the image-bearing member via the transfer material to transfer the toner image from the image-  
5 baring member onto the transfer material.

48. An image forming apparatus, comprising: an image-bearing member, a charging means for charging the image-bearing member, an electrostatic latent-  
10 image forming means forming an electrostatic latent image on the charged image-bearing member, a developing means including a toner-carrying member for transferring a magnetic toner carried on the toner-carrying member onto the electrostatic latent image to  
15 form a toner image thereon, and a transfer means for electrostatically transferring the toner image on the image-bearing member onto a transfer material via or without via an intermediate transfer member,

wherein the charging means comprises a  
20 charging member supplied with a voltage and abutted against the image-bearing member to form a contact nip with the image-bearing member,

the image-bearing member comprises an electroconductive support and a photoconductor layer  
25 comprising a silicon-based non-single crystal material and disposed on the electroconductive support, and is charged to a potential of 250 to 600 volts in terms of

an absolute value via the charging member abutted against it,

the magnetic toner includes magnetic toner particles comprising at least a binder resin and a  
5 magnetic iron oxide, and inorganic fine powder and electroconductive fine powder present at the surface of the magnetic toner particles,

the magnetic toner has a weight-average  
particle size of 3 - 10  $\mu\text{m}$ ,  
10 the magnetic toner has an average circularity of 0.950 to 0.995, and  
the magnetic toner contains 0.05 to 3.00 % of isolated iron-containing particles.

15 49. The apparatus according to Claim 48, wherein the developing means also functions as a means for recovering a portion of the magnetic toner remaining on the image-bearing member after transferring the toner image onto the transfer material.

20 50. The apparatus according to Claim 48, wherein in the charging means, the image-bearing member is charged to a potential of 250 to 550 volts in terms of an absolute value.

25 51. The apparatus according to Claim 48, wherein in the charging means, the image-bearing member is

charged to a potential of 250 to 500 volts in terms of  
an absolute value.

52. The apparatus according to Claim 48, wherein  
5 the image-bearing member is free from a means for  
warming it.

53. The apparatus according to Claim 48, wherein  
the image-bearing member has a laminate structure  
10 including an electroconductive support, a  
photoconductor layer comprising a silicon-based non-  
single crystal material and a surfacemost layer  
comprising a non-single crystal material different  
from that of the photoconductor layer.

15 54. The apparatus according to Claim 48, wherein  
the surfacemost layer comprises a non-single crystal  
carbon hydride film.

20 55. The apparatus according to Claim 48, wherein  
the charging means is a means for charging the image-  
bearing member by abutting the charging member against  
the image-bearing member via electroconductive fine  
powder.

25 56. The apparatus according to Claim 55, wherein  
the electroconductive fine powder is present at a

density of at least  $10^3$  particles/mm<sup>2</sup>.

57. The apparatus according to Claim 48, wherein the image-bearing member is charged while moving the  
5 image-baring member and the charging member so as to provide a relative speed difference between surface moving speeds of these members at the contact position.

10 58. The apparatus according to Claim 57, wherein the image-bearing member and the charging member are moved in mutually opposite surface moving directions at the contact position.

15 59. The apparatus according to Claim 48, wherein the charging member is a roller member having an Asker C hardness of at most 50 deg.

20 60. The apparatus according to Claim 48, wherein the charging member is a roller member having a volume-resistivity of  $10^3 - 10^8$  ohm.cm.

25 61. The apparatus according to Claim 48, wherein the charging member is a roller member having a surface provided with minute cells providing an average spherical cell diameter of 5 - 300  $\mu$ m and a void real percentage at the surface of 15 - 90 %.

62. The apparatus according to Claim 48, wherein the charging member is an electroconductive brush member supplied with a voltage to charge the image-bearing member.

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63. The apparatus according to Claim 48, wherein the charging member is supplied with a DC voltage alone or in superposition with an AC voltage having a peak-to-peak voltage of below  $2 \times V_{th}$  relative to a discharge initiation voltage  $V_{th}$  in DC voltage application.

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64. The apparatus according to Claim 48, wherein the charging member is supplied with a DC voltage alone or in superposition with an AC voltage having a peak-to-peak voltage of below  $V_{th}$  relative to a discharge initiation voltage  $V_{th}$  in DC voltage application.

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65. The apparatus according to Claim 48, wherein the charging member comprises a magnetic brush formed of magnetically constrained magnetic particles and is supplied with a voltage while contacting the image-bearing member to charge the image-bearing member.

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66. The apparatus according to Claim 65, wherein the magnetic particles have a volume-basis median

diameter of 10 - 50  $\mu\text{m}$ .

67. The apparatus according to Claim 65, wherein  
the magnetic particles have a volume resistivity of  
5  $1 \times 10^4 - 1 \times 10^9$  ohm.cm.

68. The apparatus according to Claim 481, wherein  
in the developing means, the magnetic toner is carried  
in a layer at a density of 5 - 50  $\text{g/m}^2$  on the toner-  
10 carrying member to develop the electrostatic latent  
image on the image-bearing member.

69. The apparatus according to Claim 48, wherein  
in the developing means, the magnetic toner is carried  
15 on the toner-carrying member in an amount regulated by  
a ferromagnetic metal blade disposed opposite to and  
with a small gap from the toner-carrying member.

70. The apparatus according to Claim 48, wherein  
20 in the developing means, the toner-carrying member is  
disposed opposite to and with a gap of 100 - 1000  $\mu\text{m}$   
from the image-bearing member.

71. The apparatus according to Claim 48, wherein  
25 in the developing means, the magnetic toner is  
disposed on the toner-carrying member in a layer  
thickness smaller than a gap between the toner-



carrying member and the image-bearing member, and is transferred onto the image-bearing member to develop the electrostatic latent image thereon.

5        72. The apparatus according to Claim 48, wherein  
in the developing means, a developing bias voltage  
comprising at least an AC voltage is applied so as to  
form an alternating electric field between the toner-  
carrying member and the image-bearing member, wherein  
10    the alternating electric field has a peak-to-peak  
intensity of  $3 \times 10^6 - 1 \times 10^7$  V/m and a frequency of 100  
- 5000 Hz.

15       73. The apparatus according to Claim 48, wherein  
the transfer means includes a transfer member abutted  
against the image-bearing member via the transfer  
material to transfer the toner image from the image-  
bearing member onto the transfer material.

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